Syllabus MSNE 437+537

revised 6May2015 by P.Loos

CRYSTALLOGRAPHY AND DIFFRACTION LAB - Selected lab experiments in materials science. This course is designed to complement the lectures in MSNE/PHYS 435/535, which must be taken concurrently or previously. The lab experiments concern the structure and constitution of materials as revealed by x-ray scattering, including diffraction and refraction. **This lab is required for the BS MSNE degree** and is optional for other degrees. Undergrads planning to stay at Rice for grad school should probably take 537.

Instructor: Peter Loos office: ME 215 Office **hours:** after class and by appointment.
Teaching Assistant: Jiangtan Yuan jy35@rice.edu
Schedule & Location: Sections meet Tue. 2:30-4:30 and Wed. 3:30-5:30 in SS B06 (basement)
Text: Cullity, ***Elements of X-ray Diffraction***, either 3rd or 2nd edition.

Grading: Based on attendance, participation, safety, ability to operate the equipment, and neatness in lab as well as completeness, correctness, organization and clarity of expression in the lab reports. Students whose efforts during the semester are unsatisfactory will have the opportunity to take a final exam for extra credit.

All students will summarize in their reports sources of error which might have affected the key quantitative results.
537 students will also include error estimates for those key results, whenever the available data and analysis tools allow it.

Absence Policy: Any absence from the hands-on data collection must be made up. Contact Instructor and/or TA as soon as it becomes apparent that such an absence cannot be avoided.

Safety: There will be a reading assignment and quiz about x-ray safety. The quiz can be taken as many times as needed to get all the answers correct.

Areas of Instruction: There will be seven lab exercises, accompanied by reading in the text and in other references.

#1 Instrument calibration, the emission spectrum of the Cu x-ray tube, filtering the spectrum.
#2 Film thickness & stress measured using (a) Scherrer's formula and a Williamson-Hall plot and (b) x-ray reflectometry (XRR).
#3 Identification of unknown powder samples using Jade and the PDF. Determination of volume fractions of multiple phases in a mixture using reference intensity ratios.
#4 Lattice parameter measurement and stoichiometry in alloys using Vegard's Law and a spreadsheet method.
#5 Plotting of split Pearson VI and split pseudo-Voight functions. Indexing unknown powder patterns using Jade.
#6 Trip to Keck 328 to see XRD equipment for large molecule crystallography. The crystals typically have lattice parameters from 150 to 500 Ang. See http://sea.rice.edu/instruments/rigaku-waxs-diffractometer.
#7 Grazing incidence XRD for thin film measurement.

Instrumentation: Dmax West will be used in experiments #2-5 and SmartLab will be used in experiments #1 and #7. These Rigaku machines are all located in SS B06. For info see http://sea.rice.edu/instruments/rigaku-dmax-east-ultima-ii-powder-xrd-6s and http://sea.rice.edu/instruments/rigaku-dmax-west-ultima-ii-powder-xrd-1s and http://sea.rice.edu/instruments/rigaku-smartlab-xrd.

Reports: Students will work together in small groups when operating the equipment and collecting & analyzing data; however, students must independently write their own lab reports per the Rice Honor Code. Lab reports are due three weeks after the data are collected. Points may be deducted for late reports.

Computation: We will use Jade software and the ICDD Powder Diffraction File (PDF) database. Four copies of this software are running on Windows machines in SS B06. Spreadsheet software will also be used extensively.

Goalsforthiscourse:
To address ABET Student Outcomes and Program Criteria, students will have
(a) an ability to apply knowledge of mathematics, science, and engineering
(e) an ability to identify, formulate, and solve engineering problems
(g) an ability to communicate effectively
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
and the course will
- prepare graduates to apply advanced science … and engineering principles to materials systems …
- prepare graduates to utilize experimental, statistical, & computational methods …

More specifically:
(1) Students will be able to determine the crystal structure of most metals and ceramics experimentally.
(2) Students will be able to use structure information to determine strain, stress, composition, orientation, density, and size of crystallites in a crystalline solid.
(3) Students will be able to use reflectometry to characterize thin films.
(4) Students will be able to assess the technical literature on this subject.

NOTICE: Any student with a disability requiring accommodations in this class is encouraged to contact Instructors after class or during office hours. Additionally, students should contact the Disabled Student Services office in the Ley Student Center.